IS 7576 (1974): Bunched enamelled copper conductors with silk covering [ETD 33: Winding Wire]

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Indian Standard

SPECIFICATION FOR BUNCHED ENAMELLED COPPER WIRES WITH SILK COVERING

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Indian Standard

SPECIFICATION FOR BUNCHED ENAMELLED COPPER WIRES WITH SILK COVERING

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Indian Standard

SPECIFICATION FOR BUNCHED ENAMELLED COPPER WIRES WITH SILK COVERING

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 26 December 1974, after the draft finalized by the Winding Wires Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 Bunched enamelled and silk covered wires are extensively used for high frequency applications, such as, for IF and RF transformers and coils. In the design of low loss high frequency coils, the eddy current losses in the conductor should be reduced to minimum. One of the ways to accomplish this is by using in place of a solid conductor, a conductor comprising plurality of enamelled wires transposed continuously along its length. The self-fluxing type of enamel is extensively used for such wires.

0.3 At the international level it has been felt that the construction of 'Litz wires' which are built up by successive stranding of wires or groups of wires as groups of three is obsolete. In view of this, Litz wires are excluded from the scope of this standard and only the 'bunched wires' have been standardized.

0.4 In the preparation of this standard, considerable assistance has been derived from the following:

IEC Publication 317-11 (1972) Specifications for particular types of wires: Part 11 Bunched enamelled copper wires with silk covering. International Electrotechnical Commission.

BS : 4770 : 1971 Specification for bunched enamelled copper conductors with silk covering. British Standards Institution.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard specifies requirements and dimensions for bunched enamelled copper wires with silk covering normally used for high frequency applications. The enamelled conductor shall conform to Fine (F) covering of IS : 4800 (Part VI)-1968*.

1.2 The requirements of the standard are applicable to bunched wires made up of wires having conductor diameters from 0·025 to 0·071 mm.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Wire — The single enamelled conductor.

2.2 Conductor — The bare copper wire after the removal of the enamel film from the single wire.

2.3 Bunched Wire — The laid up composite with its textile covering.

2.4 Lay — The axial length of one complete turn of the helix formed by the bunched wire.

2.5 Tolerance — The permissible divergence of an actual magnitude from that prescribed.

2.6 Dielectric Dissipation factor (tan δ) — The tangent of the loss angle of an insulating material.

3. GENERAL TEST CONDITIONS

3.1 Unless otherwise specified, all tests shall be carried out within a temperature range of 15 to 35°C and a relative humidity range of 45 to 75 percent. Before measurements are made, the specimens shall be preconditioned under these atmospheric conditions for a time sufficient to allow the wire to reach stability.

3.2 The bunched wire to be tested shall be removed from the packaging in such a way that the wire will not be subjected to tension or unnecessary bends.

3.3 Before each test discard sufficient length of wire to ensure that any damaged wire is not included in the test specimens.

3.4 Normally all mandatory requirements for a method of test are given in the description, and diagrams are only intended to illustrate one possible arrangement for conducting the test.

*Specification for enamelled round winding wires: Part VI Wires with self-fluxing properties.

4. OVERALL DIAMETER

4.1 Overall Diameter of Single Wire — The maximum overall diameter and the minimum increase in diameter of the single wire shall be in accordance with Table 1.

TABLE 1 OVERALL DIAMETER OF THE SINGLE WIRE

Nominal Conductor Diameter (1) mm	Maximum Overall Diameter (2) mm	Minimum Increase in Diameter (3) mm
0·025	0·031	0·002 5
0·032	0·040	0·003
0·040	0·050	0·004
0·050	0·062	0·005
0·063	0·078	0·007
0·071	0·088	0·008

NOTE — Bunched wires with a diameter of single wire of 0·071 mm are not recommended for new designs.

4.2 Nominal Overall Diameter of Bunched Wire — The number of wires and the nominal overall diameter of the bunched wire when measured in accordance with Appendix A shall be in accordance with Table 2.

4.2.1 The figures given in Table 2 are related to the measurement on a mandrel. The real figures measured with a microscope are approximately 8 percent lower.

4.3 Maximum Overall Diameter of Bunched Wire — The maximum value of overall diameter, when measured on the mandrel, shall be not more than 10 percent higher than the figures given in Table 2.

5. RESISTANCE

5.1 The resistance for the preferred sizes at 20°C shall be within the limits given in Table 3 and shall be calculated as described in Appendix C.

5.1.1 The nominal cross-sectional area calculated by the method described in Appendix D, and the nominal resistance calculated by the method described in Appendix C are given in Appendix D.

NOTE — Resistance of non-preferred sizes is given in Appendix B.

6. COVERING

6.1 Application — The bunched enamelled copper wires shall have a covering of one or two lappings of silk.

The first lapping shall be applied to the bunched wires in a direction opposite to the twist of the bunched wire. If a second lapping is applied it shall be in the opposite direction to the first lapping.

The covering shall be uniform in quality and each lapping shall be even and uniform.

6.2 Mandrel Winding Test — The bunched wire shall be wound on a mandrel with a diameter 10 times the overall diameter given in Table 2 or Appendix B, under a tension calculated according to the following formula:

$$\text{Tension in N} = 65 \times \text{total nominal cross-sectional area of the conductor in mm}^2$$

In winding the wire round the mandrel, care shall be taken not to introduce a twist in the wire for each revolution.

The winding shall then be examined with normal vision in diffused light. The silk covering shall not open sufficiently to expose clearly the enamelled wire.

Three tests shall be made.

TABLE 2 NOMINAL OVERALL DIAMETER OF BUNCHED WIRE (PREFERRED SIZES)

(*Clauses* 4.2, 4.3 *and* 6.2)

Number of Wires	Nominal Overall Diameter for Nominal Conductor Diameter of the Single Wire				
	0·025 mm	0·032 mm	0·040 mm	0·050 mm	0·063 mm
(1)	(2)	(3)	(4)	(5)	(6)
	mm	mm	mm	mm	mm
3	0·095	0·115	0·135	0·160	0·190
4	0·105	0·125	0·150	0·180	0·215
5	0·115	0·140	0·165	0·195	0·235
6	0·120	0·150	0·175	0·210	0·255
8	0·135	0·165	0·200	0·240	0·290
10	0·150	0·180	0·220	0·260	0·320
12	0·160	0·195	0·235	0·285	0·350
20	0·200	0·245	0·300	0·360	0·450
25	0·220	0·275	0·335	0·405	0·505
32	0·245	0·305	0·375	0·455	0·565
40	0·270	0·335	0·415	0·505	0·630
60	0·320	0·405	0·500	0·615	0·785
100	0·405	0·515	0·640	0·805	1·000
160	0·505	0·670	0·825	1·005	1·255
250	0·625	0·820	1·015	1·245	1·550

NOTE 1 — The number of wires is taken from the R series of preferred numbers, and rounded for technical reasons.

NOTE 2 — Above the line, normally one silk layer is applied and below the line, a double silk layer is applied.

NOTE 3 — The overall diameter is calculated according to the method given in Appendix A.

NOTE 4 — Overall diameters for other commonly used non-preferred sizes are given in Appendix B.

TABLE 3 RESISTANCE OF THE BUNCHED WIRE (PREFERRED SIZES)

(*Clause* 5.1)

Number of Wires	Resistance of Bunched Wire for Nominal Conductor Diameter of Single Wire									
	0·025 mm		0·032 mm		0·040 mm		0·050 mm		0·063 mm	
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m
3	10·18	13·97	6·290	8·310	4·070	5·226	2·634	3·284	1·678	2·050
4	7·638	10·48	4·718	6·232	3·053	3·919	1·976	2·463	1·258	1·537
5	6·110	8·562	3·774	4·986	2·442	3·135	1·581	1·970	1·007	1·230
6	5·092	6·985	3·145	4·155	2·035	2·613	1·317	1·642	0·839	1·025
8	3·819	5·239	2·359	3·116	1·526	1·960	0·988	1·232	0·629	0·769
10	3·055	4·191	1·887	2·493	1·221	1·568	0·790	0·985	0·583	0·615
12	2·546	3·493	1·573	2·077	1·018	1·306	0·659	0·821	0·429	0·512
20	1·528	2·096	0·944	1·246	0·611	0·784	0·395	0·493	0·252	0·307
25	1·222	1·676	0·755	0·977	0·488	0·627	0·316	0·394	0·201	0·246
32	0·955	1·349	0·590	0·802	0·382	0·505	0·247	0·317	0·157	0·198
40	0·764	1·079	0·472	0·642	0·305	0·404	0·198	0·254	0·126 1	0·158
60	0·509	0·719	0·315	0·428	0·204	0·269	0·132	0·169	0·083 9	0·106
100	0·306	0·432	0·189	0·257	0·122	0·161	0·079 0	0·101	0·050 3	0·063 3
160	0·191	0·270	0·118	0·160	0·076 3	0·101	0·049 4	0·063 4	0·031 5	0·039 6
250	0·122	0·173	0·075 5	0·103	0·048 8	0·064 6	0·031 6	0·040 6	0·020 1	0·025 3

7. DIELECTRIC DISSIPATION FACTOR

7.1 The bunched wire shall be tested by the method described in **5.13** of IS : 4800 (Part III)-1968* immediately after conditioning for 24 hours at a relative humidity 91 to 95 percent and at a temperature of 20 to 30°C.

7.1.1 The dielectric dissipation factor at approximately 1 MHz shall not exceed 300×10^{-4}.

8. SOLDER TEST

8.1 The bunched wire shall be tested by the method described in **5.14** of IS : 4800 (Part III)-1968*.

Temperature of the solder bath shall be 375 ± 5°C.
The immersion time shall be that specified in Table 4.
The silk covering shall be removed.

On completion of the test, the solder shall have penetrated the whole of the bunch and the outside shall have a smooth coating with evidence of effective solder coating.

TABLE 4 IMMERSION TIME IN SOLDER BATH

Nominal Cross-Sectional Area of the Bunched Wire		Immersion Time
Over	Up to and Including	
(1) mm²	(2) mm²	(3) seconds
—	0·08	3
0·08	0·125	4
0·125	0·2	5
0·2	0·3	6
0·3	0·5	8
0·5	0·8	10
0·8	—	As agreed

9. LENGTH OF LAY

9.1 The length of lay shall not exceed 60 mm.

10. PACKING AND MARKING

10.1 The bunched wire shall be wound evenly and compactly on reels complying with IS : 482-1968†. Each reel shall contain not more than two lengths of bunched wire.

*Specification for enamelled round winding wires: Part III Methods of tests.
†Specification for reels for covered, round electrical winding wires (*second revision*).

10.2 The label which is to be securely attached to the reel shall have the following information :

a) A reference to this Indian Standard, for example 'Ref IS 7576'

b) Manufacturer's name or trade-mark;

c) Type of enamel, that is, with self-fluxing properties;

d) Number of wires and diameter of wire; and

e) Weight of wire (gross and net).

10.2.1 The label may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control, which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

11. SAMPLING

11.1 A recommendatory sampling plan and criteria for acceptance of lot are given in Appendix E.

APPENDIX A

[*Clause* 4.2 and *Table* 2 (*Note* 3)]

CALCULATION AND MEASUREMENT OF OVERALL DIAMETER OF BUNCHED WIRE

A-1. CALCULATION OF THE NOMINAL OVERALL DIAMETER

A-1.1 The nominal overall diameter of the bunched wire has been calculated with the following formula :

$$D = pd\sqrt{n} + \text{the increase caused by the silk covering}$$

where

D = nominal bunched wire diameter,

p = the packing factor (*see* Table 5),

n = number of single wires, and

d = nominal overall diameter of the single wire (*see* Note) (*see* Table 6).

TABLE 5 PACKING FACTOR

(*Clause* A-1.1)

Number of Wires (1)	Packing Factor (2)
From 3 to 6	1·25
7	1·15
From 8 to 12	1·25
16	1·26
20	1·27
From 25 to 400	1·28

NOTE — Nominal overall diameter of the single wire is the nominal conductor diameter plus 2/3 of the maximum increase of Fine wires according to IS : 4800 (Part II)-1968*. The nominal overall diameter of the silk covered bunched enamelled conductors is the nominal overall diameter of the bunched enamelled conductors plus the increase in diameter caused by the silk covering (*see* table below):

Nominal Overall Diameter of the Bunched Enamelled Conductors			*Increase in Diameter Caused by Silk Covering*
Covering	Over	Up to and Including	
(1)	(2) mm	(3) mm	(4) mm
Single silk	—	0·450	0·030 to 0·035
	0·450	0·600	0·035 to 0·040
Double silk	0·600	1·000	0·060 to 0·070
	1·000		0·070 to 0·080

The single silk covering is recommended for bunched enamelled conductors of overall diameters up to and including 0·600 mm.

TABLE 6 CALCULATED NOMINAL OVERALL DIAMETER OF SINGLE WIRE

(*Clause* A-1.1)

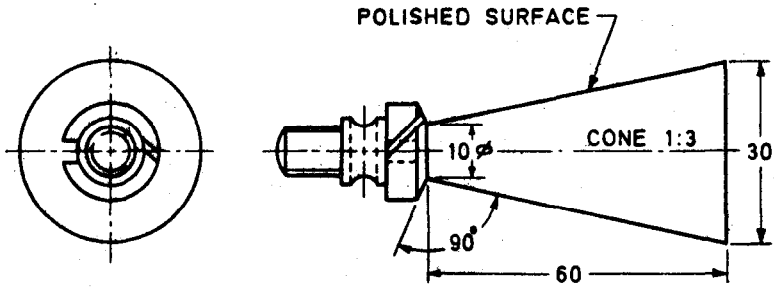
Nominal Conductor Diameter (1) mm	Nominal Overall Diameter (2) mm
0·025	0·029
0·032	0·037 4
0·040	0·047
0·050	0·058
0·063	0·073
0·071	0·082

*Specification for enamelled round winding wires: Part II Maximum overall diameters.

A-2. MEASUREMENT OF OVERALL DIAMETER

A-2.1 General — The method indicated below does not give accurate values for use in practice but only an approximation of an overall diameter.

A-2.2 Measuring Equipment — The overall diameter is determined with a polished conical mandrel having the dimensions shown in Fig. 1.



All dimensions in millimetres.

FIG. 1 CONICAL MANDREL

A-2.3 Measuring Method — The overall diameter is determined by closely winding the wire on the mandrel under a tension calculated according to the following formula:

$$\text{Tension in N} = 65 \times \text{total nominal cross-sectional area of the conductor in mm}^2$$

The width of the layer so formed should be not less than 10 mm for wires with nominal overall diameters of up to and including 0·5 mm, and not less than 20 mm for larger diameter.

The width should be measured with an accuracy of 0·5 mm.

The width of the layer divided by the number of turns gives the overall diameter of the bunched wire rounded off to 0·01 mm.

Three measurements shall be made.

APPENDIX B

[*Clause* 6.2 and *Table* 2 (*Note* 4)]

OVERALL DIAMETER AND RESISTANCE OF BUNCHED WIRE (NON-PREFERRED SIZES)

B-1. OVERALL DIAMETER AND RESISTANCE

B-1.1 The overall diameter and resistance of non-preferred sizes of bunched wires are given in Tables 7, 7A, and 8 respectively.

TABLE 7 NOMINAL OVERALL DIAMETER OF BUNCHED WIRE (NONPREFERRED SIZES)

(*Clause* B-1.1)

Number of Wires	Nominal Overall Diameter for Nominal Conductor Diameter of the Single Wire				
	0·025 mm	0·032 mm	0·040 mm	0·050 mm	0·063 mm
(1)	(2)	(3)	(4)	(5)	(6)
	mm	mm	mm	mm	mm
7	0·120	0·150	0·175	0·210	0·255
9	0·140	0·175	0·210	0·250	0·295
16	0·180	0·220	0·270	0·325	0·400
27	0·225	0·280	0·345	0·420	0·525
36	0·255	0·320	0·395	0·480	0·600
50	0·295	0·370	0·460	0·560	0·725
63	0·330	0·415	0·515	0·625	0·805
80	0·365	0·460	0·575	0·725	0·900
81	0·370	0·465	0·580	0·730	0·905
120	0·440	0·560	0·720	0·875	1·095
135	0·465	0·595	0·760	0·925	1·155
200	0·560	0·740	0·915	1·120	1·395
320	0·730	0·920	1·150	1·400	1·750
400	0·805	1·020	1·280	1·560	1·940

NOTE — Above the line, normally one silk layer is applied and below the line, a double silk layer is applied.

TABLE 7A NOMINAL OVERALL DIAMETER OF BUNCHED WIRE FOR SINGLE WIRE SIZE 0·071 mm

(*Clause* B-1.1)

Number of Wires	Nominal Conductor Diameter of the Single Wire 0·071 mm	Number of Wires	Nominal Conductor Diameter of the Single Wire 0·071 mm
(1)	(2)	(1)	(2)
	mm		mm
		40	0·730
3	0·210	50	0·810
4	0·240	60	0·880
5	0·260	63	0·900
6	0·285		
7	0·285	80	1·005
8	0·325	81	1·010
9	0·340	100	1·120
10	0·355	120	1·220
12	0·390	180	1·400
16	0·445	260	1·560
20	0·500	250	1·735
25	0·560	320	1·950
27	0·585	400	2·180
32	0·630		

TABLE 8 RESISTANCE OF BUNCHED WIRE (NON-PREFERRED SIZES)

(*Clause* B-1.1)

Number of Wires	Resistance of the Bunched Wire for Nominal Conductor Diameter of the Single Wire											
	0·025 mm		0·032 mm		0·040 mm		0·050 mm		0·063 mm		0·071 mm	
	Min	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m	Ω/m
7	4·364	5·987	2·696	3·561	1·744	2·240	1·129	1·407	0·719	0·879	0·569	0·689
9	3·394	4·657	2·097	2·770	1·357	1·742	0·878	1·095	0·559	0·683	0·443	0·536
16	1·909	2·619	1·179	1·558	0·763	0·980	0·494	0·616	0·315	0·384	0·249	0·301
27	1·131	1·599	0·699	0·951	0·452	0·598	0·293	0·376	0·186	0·235	0·148	0·184
36	0·849	1·198	0·524	0·713	0·339	0·448	0·220	0·282	0·140	0·176	0·111	0·138
50	0·611	0·863	0·377	0·514	0·244	0·323	0·158	0·203	0·101	0·127	0·079 7	0·099 3
63	0·485	0·689	0·300	0·408	0·194	0·256	0·125	0·161	0·079 9	0·101	0·063 3	0·078
80	0·382	0·540	0·236	0·321	0·153	0·202	0·098 8	0·127	0·062 9	0·079 2	0·049 8	0·062 0
81	0·377	0·533	0·233	0·317	0·151	0·199	0·097 6	0·125	0·062 1	0·078 2	0·049 2	0·061 3
120	0·255	0·360	0·157	0·214	0·102	0·135	0·065 9	0·084 6	0·041 9	0·052 8	0·033 2	0·041 3
135	0·226	0·320	0·140	0·190	0·090 4	0·120	0·058 5	0·075 2	0·037 3	0·046 9	0·029 5	0·036 8
200	0·153	0·216	0·094 4	0·128	0·061 1	0·080 7	0·039 5	0·050 7	0·025 2	0·031 7	0·019 9	0·024 8
320	0·095 5	0·135	0·059 0	0·080 2	0·038 2	0·050 5	0·024 7	0·031 7	0·015 7	0·019 8	0·012 5	0·015 5
400	0·076 4	0·108	0·047 2	0·064 2	0·030 5	0·040 4	0·019 8	0·025 4	0·012 6	0·015 8	0·009 96	0·012 4

NOTE — The limits shown above are derived from calculation made according to Appendix C.

APPENDIX C

(*Clauses* 5.1 *and* 5.1.1)

CALCULATION AND MEASUREMENT OF RESISTANCE OF BUNCHED WIRE

C-1. CALCULATION OF THE RESISTANCE

C-1.1 For the calculation of the resistance, the resistance of the single wires given in IS : 4800 (Part I)-1968* has been used:

$$\text{Nominal resistance} = \frac{\text{Nominal resistance of single wire}}{\text{Number of wires}} \times 1{\cdot}02$$

$$\text{Minimum resistance} = \frac{\text{Minimum resistance of single wire}}{\text{Number of wires}}$$

$$\text{Maximum resistance (number of wires} \leqslant 25) = \frac{\text{Maximum resistance of single wire}}{\text{Number of wires}} \times 1{\cdot}02$$

$$\text{Maximum resistance (number of wires} > 25) = \frac{\text{Maximum resistance of single wire}}{\text{Number of wires}} \times 1{\cdot}02 \times 1{\cdot}03$$

NOTE 1—The factor 1·02 is taken because of the decrease in length due to bunching.

NOTE 2—The factor 1·03 is taken because of the broken ends which may occur.

C-2. MEASUREMENT OF RESISTANCE AND CHECKING FOR BROKEN ENDS

C-2.1 The resistance of the bunched wire is measured on a length of 10 m and is expressed as the dc resistance at 20°C. The method used should provide an accuracy of 0·5 percent.

Before the measurement, the ends are soldered.

If the resistance R_t is measured at a temperature t other than 20°C, the resistance R_{20} at 20°C is calculated by means of the formula :

$$R_{20} = \frac{R_t}{1 + \alpha\,(t - 20)}$$

where

t is the actual temperature in °C during the measurement and α is the temperature coefficient (for the particular case of copper, $\alpha = 0{\cdot}003\,93$).

One measurement should be made.

*Specification for enamelled round winding wires: Part I Conductor data.

APPENDIX D

(*Clause* 5.1.1)

CALCULATED CROSS-SECTIONAL AREA AND RESISTANCE OF BUNCHED WIRES

D-1. NOMINAL CROSS-SECTIONAL AREA

D-1.1 The nominal cross-sectional area (q) of the bunched wire given in Table 9 and 10 is calculated from the formula:

$$q = \frac{\pi}{4} d^2_{\text{nom}} \times n \times 1{\cdot}02$$

where

d_{nom} = nominal diameter of the conductor, and

n = number of wires.

D-1.2 The factor 1·02 allows for the decrease in length due to bunching.

D-2. NOMINAL RESISTANCE

D-2.1 The nominal resistance has been calculated as described in Appendix C.

TABLE 9 NOMINAL CROSS-SECTIONAL AREA AND RESISTANCE OF BUNCHED WIRE (PREFERRED SIZES)

(*Clause* D-1.1)

Number of Wires	Nominal Conductor Diameter of Single Wire											
	0·025 mm		0·032 mm		0·040 mm		0·050 mm		0·063 mm		0·071 mm	
	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m
3	0·001 50	11·94	0·002 46	7·290	0·003 85	4·665	0·006 01	2·986	0·009 54	1·881	0·012 1	1·481
4	0·002 00	8·956	0·003 28	5·467	0·005 13	3·499	0·008 01	2·239	0·012 7	1·410	0·016 2	1·111
5	0·002 50	7·164	0·004 10	4·374	0·006 41	2·799	0·010 0	1·791	0·015 9	1·128	0·020 2	0·888
6	0·003 00	5·970	0·004 92	3·645	0·007 69	2·332	0·012 0	1·493	0·019 1	0·940	0·024 2	0·740
8	0·004 01	4·478	0·006 56	2·734	0·010 3	1·749	0·016 0	1·120	0·025 4	0·705	0·032 3	0·555
10	0·005 01	3·582	0·008 20	2·187	0·012 8	1·399	0·020 0	0·896	0·031 8	0·564	0·040 4	0·444
12	0·006 01	2·985	0·009 84	1·822	0·015 4	1·166	0·024 0	0·746	0·038 2	0·470	0·048 5	0·370
20	0·010 0	1·791	0·016 4	1·093	0·025 6	0·700	0·040 1	0·448	0·063 6	0·282	0·080 8	0·222
25	0·012 5	1·433	0·020 5	0·875	0·032 0	0·560	0·050 1	0·358	0·079 5	0·226	0·101	0·178
32	0·016 0	1·119	0·026 3	0·683	0·041 0	0·437	0·064 1	0·280	0·102	0·176	0·129	0·139
40	0·020 0	0·896	0·032 8	0·547	0·051 3	0·350	0·080 1	0·224	0·127	0·141	0·162	0·111
60	0·030 0	0·597	0·049 2	0·364	0·076 9	0·233	0·012 0	0·149	0·191	0·094 0	0·242	0·074 0
100	0·050 1	0·358	0·082 0	0·219	0·128	0·140	0·200	0·089 6	0·318	0·056 4	0·404	0·044 4
160	0·080 1	0·224	0·131	0·137	0·205	0·087 5	0·320	0·056 0	0·509	0·035 3	0·646	0·027 8
250	0·125	0·143	0·205	0·087 5	0·320	0·056 0	0·501	0·035 8	0·795	0·022 6	1·010	0·017 8

TABLE 10 NOMINAL CROSS-SECTIONAL AREA AND RESISTANCE OF BUNCHED WIRE (NON-PREFERRED SIZES)

(*Clause* D-1.1)

Number of Wires	Nominal Conductor Diameter of Single Wire											
	0·025 mm		0·032 mm		0·040 mm		0·050 mm		0·063 mm		0·071 mm	
	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance	Nominal Cross section	Nominal Resistance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m	mm²	Ω/m
7	0·003 51	5·117	0·005 74	3·124	0·008 97	1·999	0·014 0	1·280	0·022 3	0·806	0·028 3	0·635
9	0·004 51	3·980	0·007 38	2·430	0·011 5	1·555	0·018 0	0·995	0·028 6	0·627	0·036 3	0·494
16	0·008 01	2·239	0·013 1	1·367	0·020 5	0·875	0·032 0	0·560	0·050 9	0·353	0·064 6	0·278
27	0·013 5	1·327	0·022 1	0·810	0·034 6	0·518	0·054 1	0·332	0·085 8	0·209	0·109	0·165
36	0·018 0	0·995 1	0·029 5	0·608	0·046 1	0·389	0·072 1	0·249	0·114	0·157	0·145	0·123
50	0·025 0	0·716	0·041 0	0·437	0·064 1	0·280	0·100	0·179	0·159	0·113	0·202	0·088 8
63	0·031 5	0·569	0·051 7	0·347	0·080 8	0·222	0·126	0·142	0·200	0·089 5	0·254	0·070 5
80	0·040 1	0·448	0·065 6	0·273	0·103	0·175	0·160	0·112	0·254	0·070 5	0·323	0·055 5
81	0·040 6	0·442	0·066 4	0·270	0·104	0·173	0·162	0·111	0·258	0·069 6	0·327	0·054 8
120	0·060 1	0·299	0·098 4	0·182	0·154	0·117	0·240	0·074 6	0·382	0·047 0	0·485	0·037 0
135	0·067 6	0·265	0·111	0·162	0·173	0·104	0·270	0·066 3	0·429	0·041 8	0·531	0·032 9
200	0·100	0·179	0·164	0·109	0·256	0·070 0	0·401	0·044 8	0·636	0·028 2	0·808	0·022 2
320	0·160	0·112	0·263	0·068 3	0·410	0·043 7	0·641	0·028 0	1·017	0·017 6	1·292	0·013 9
400	0·200	0·089 6	0·328	0·054 7	0·513	0·035 0	0·801	0·022 4	1·272	0·014 1	1·615	0·011 1

APPENDIX E

(*Clause* 11.1)

RECOMMENDED SAMPLING PLAN AND CRITERIA FOR ACCEPTANCE OF LOT

E-1. LOT

E-1.1 In any consignment all the reels of bunched wire of the same size and manufactured from the same material under essentially similar conditions of production shall be grouped together to constitute a lot.

E-2. SCALE OF SAMPLING

E-2.1 Tests for judging the conformity of a lot to the requirements of the specification shall be done for each lot separately. For this purpose, the number of reels to be selected at random from a lot shall be in accordance with Table 11.

E-3. NUMBER OF TESTS AND CRITERIA FOR ACCEPTANCE

E-3.1 From each of the reels selected according to col 2 of Table 11 (Scale A), suitable lengths of test samples shall be taken after discarding approximately 1·5 metre length of the wire. These test samples shall be subjected to each of covering test, dielectric dissipation test, solder test and length of lay. A test sample is called defective if it fails in anyone or more of these requirements. If the number of test samples not fulfilling the requirements of any of the tests is less than or equal to the corresponding permissible number given in col 3 of Table 11, the lot shall be declared as conforming to the requirement of these tests.

TABLE 11 SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES

(*Clauses* E-2.1, E-3.1 *and* E-3.2)

Lot Size	Scale A		Scale B	
	Number of Reels to be Selected in the Sample	Permissible No. of Defectives	Number of Reels to be Selected in the Sample	Permissible No. of Defectives
(1)	(2)	(3)	(4)	(5)
Up to 300	20	0	13	0
301 to 500	32	1	20	0
501 to 1 000	50	2	32	1
1 001 to 3 000	80	3	50	2
3 001 and above	125	5	80	3

E-3.2 For each of the characteristics, diameter and resistance, the number of tests to be carried out and the permissible number of defectives shall be in accordance with col 4 and 5 of Table 11 (Scale B). The test samples for carrying out these tests under Scale B may be chosen from the reels already selected under Scale A.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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